A Cost Effective Approach to Finding Sources of Inflow and Infiltration in Sanitary Sewers Systems

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December 12, 2013

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Date

Agenda

1. Identify Project Objectives
2. History of Inflow & Infiltration Studies
3. I/I Reduction in Vulnerable Areas
4. Micro-monitoring
5. Early Ditch Green Alternative
6. Take Away Message

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Identify Project Objectives

Objective	Basis
System Capacity	Level of Service
SSO Elimination	Regulatory
Non-surcharging condition	Good Operations
Properly size facilities	Design Requirement

Without a defined plan of action to address SSOs, it is unlikely that the Ohio EPA will allow additional users to connect to the system.

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History of I/I Investigations

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History of Inflow and Infiltration Studies

- Interpretations of definition of "I/I" date back to the USEPA Construction Grants Program.
- Originally, I/I investigations were narrow in scope and limited to broad brush categorizations for sub-basins that did not seek to pin point sources of I/I.
- Flows quantified on GPD/inch-mile of sewer including laterals.
- And was based almost exclusively on flow monitoring and data review, and follow-up investigations were necessary

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History of Inflow and Infiltration Studies

- SSES followed I/I investigations and included manhole inspection, smoke testing, dye flooding/testing, and CCTV investigations, and additional flow monitoring.
- The definition of I/I evolved over time and is used now almost interchangeably with SSES.
- Studies previous to the middle 1990s were hampered by limitations in CCTV and flow monitoring.
- There was also a fundamental misunderstanding of what is meant by the terms "inflow and infiltration."

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History of Inflow and Infiltration Studies

- Oakland MUD coined the term "rainfall derived I/I" in a JWCPF article in 1987.
- RDII was a term that was between "inflow" and "infiltration. It is also called "delayed inflow" or "rapid infiltration." It was evolutionary in the understanding of I/I.
- Over time, there became a greater understanding of the importance of private property I/I where about 50% of total system I/I exists.
- There also grew a greater understanding of how I/I and storm water drainage issues are inter-related.

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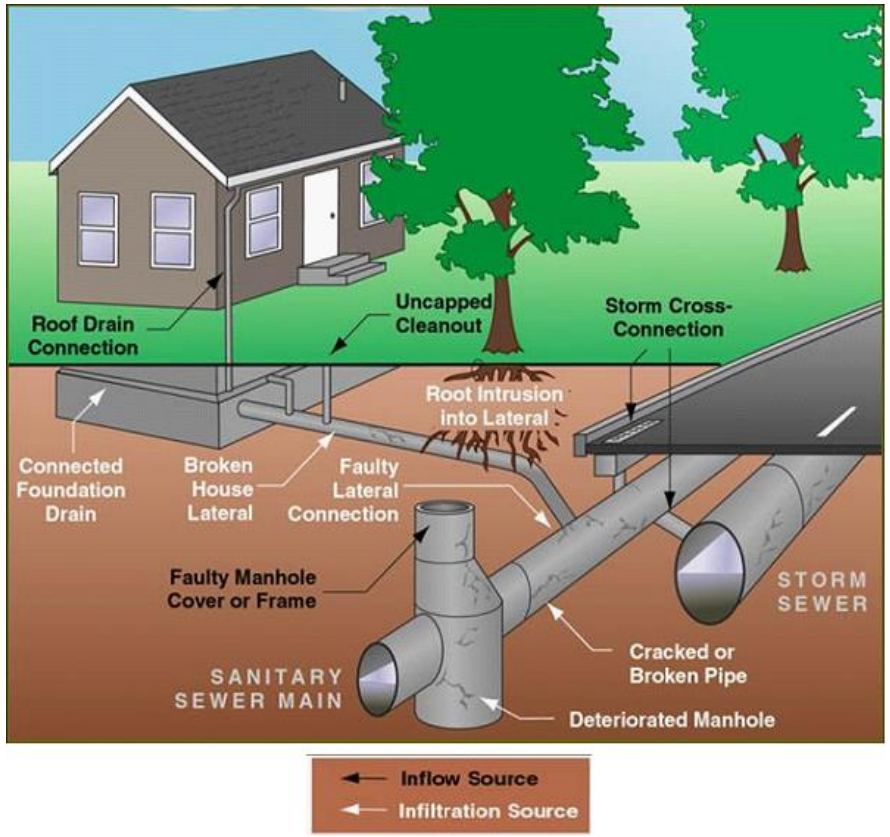
I/I Source Theory

- Most I/I sources are neither large, nor intentional.
- Sources start as small defects that develop "water channels."
- Water channels wash away bedding material under pipes causing failure.
- Common problem areas are storm sewers overlying sanitary sewers.



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Traditional I/I Investigation

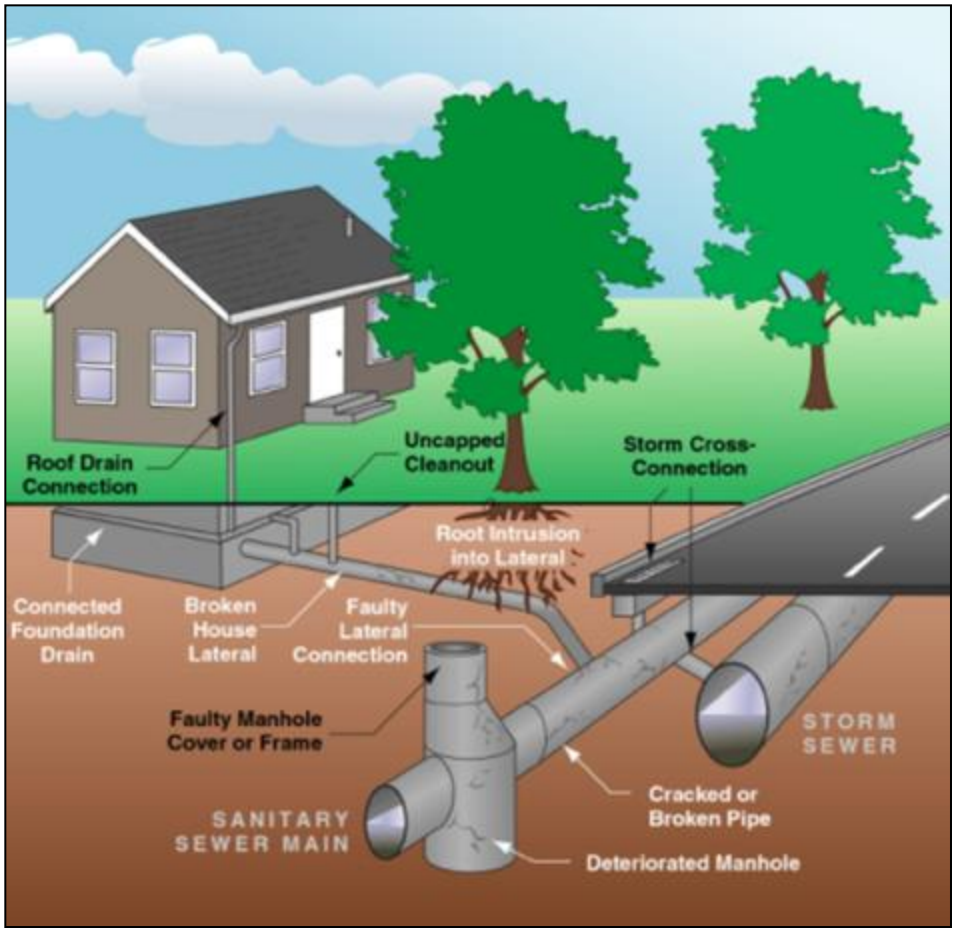
Traditional Flow Monitoring

Manhole Inspection

Wet Weather Response

CCTV

Smoke and Dye Testing



What are I/I Vulnerable Areas?

- Areas where sanitary sewer pipe is shown to be defective (NASSCO PACP, Class 4 and 5 defects)
- Poor surface drainage and conveyance
- Sanitary and storm infrastructure in close proximity
- Photo to right is the Columbus Early Ditch Project, Great Western Shopping Center. Sanitary sewer and ditch are a few feet apart.

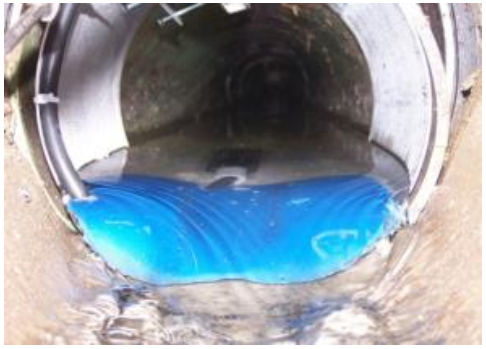
Approach for I/I Vulnerable Areas

Consider options for peak flow reductions for I/I Vulnerable Areas

Investigate I/I

Storm Water System Improvements

Micro-Monitoring



Micro Monitoring

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Flow Measurement: Techniques

Not all data measuring devices are the same!

Devices used may include

- Flow Monitoring – Conventional (Gold Standard)
- Flow Monitoring – Micro-monitor
- Data Logger – Level and Temperature

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Flow Measurement: Conventional Flow Meter

- Sanitary Sewers 10-inches in diameter and larger
- Proven reliable technology: used by Columbus, MSD Cincinnati, and other large metropolitan sewer agencies
- Stantec is nationally known flow monitoring expert

Conventional Flow Meter

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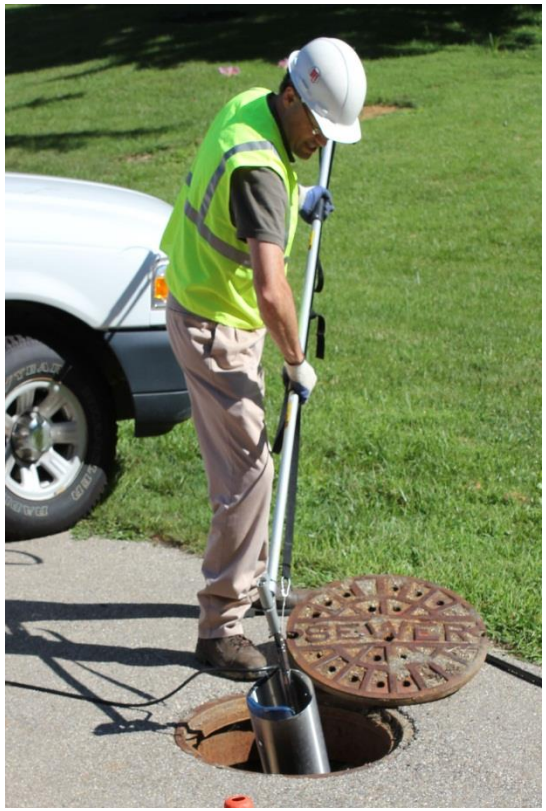
Flow Measurement: Micrometer

- Sanitary Sewers 8" and less
- Very effective in low flow situations
- Confined space entry not required: a cost savings!
- Can be a "stand alone" tool for I/I source finding
- Developed by Dr. John Barton of Stantec



Installation of a Micro-Meter

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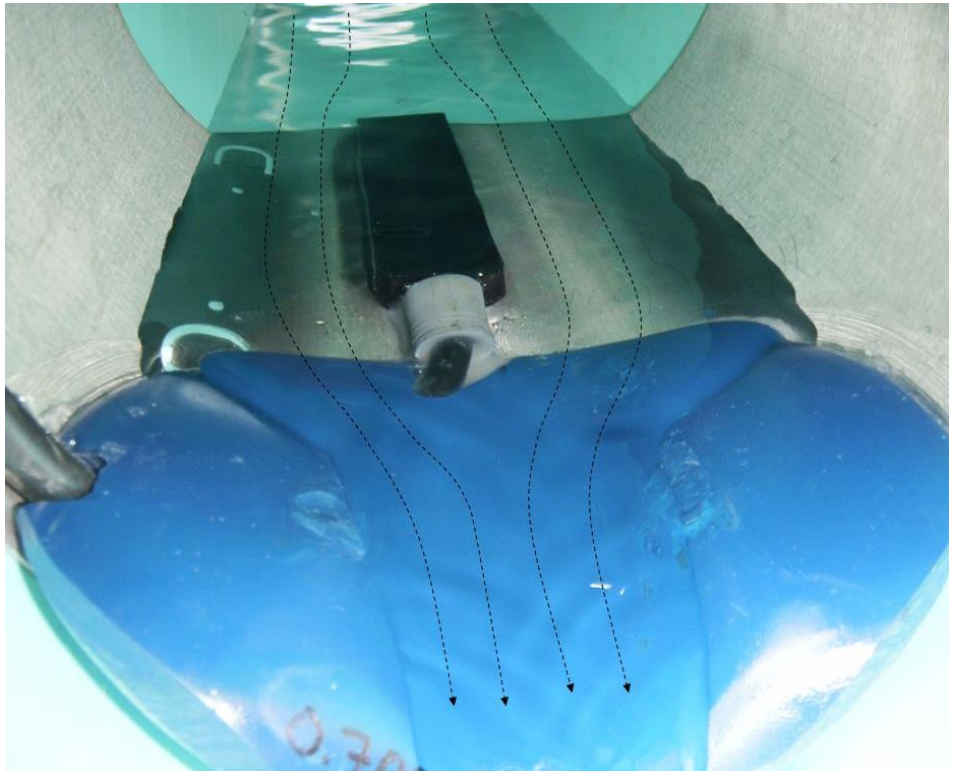
Micrometer - Adaptive Means to Accommodate Low Flow Situations

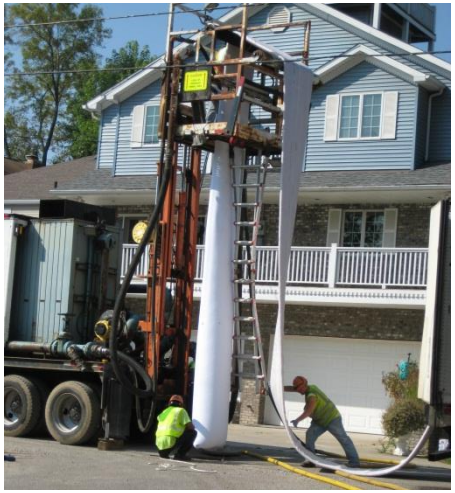


Low Profile Probe Flow Low Flow Applications

Flow Shark Flow Meter

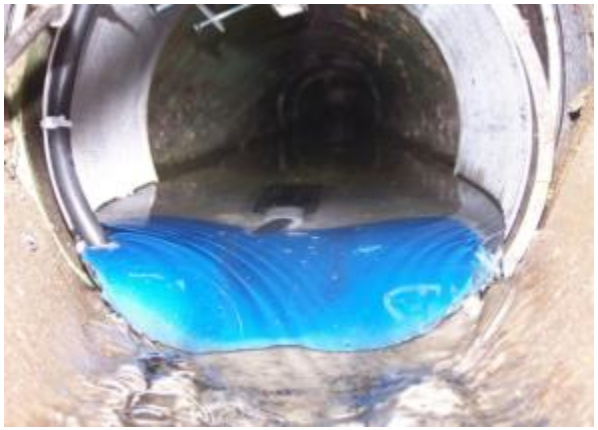
I/I Removal Approach - Methods

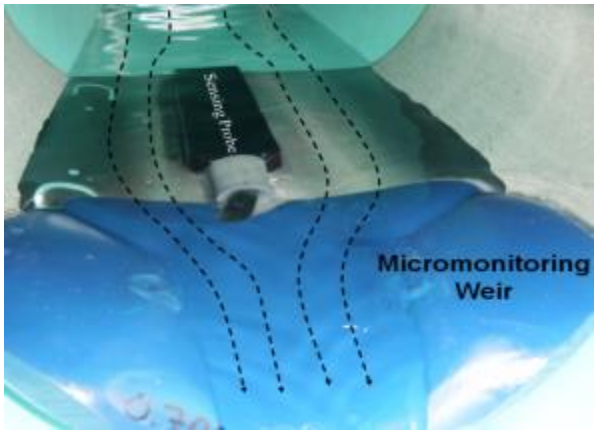
- CIPP Lining Mainline Structural Defects
- CIPP Lining Laterals
- Manhole Rehabilitation
- Addressing Storm Deficiencies – **Green Technologies**



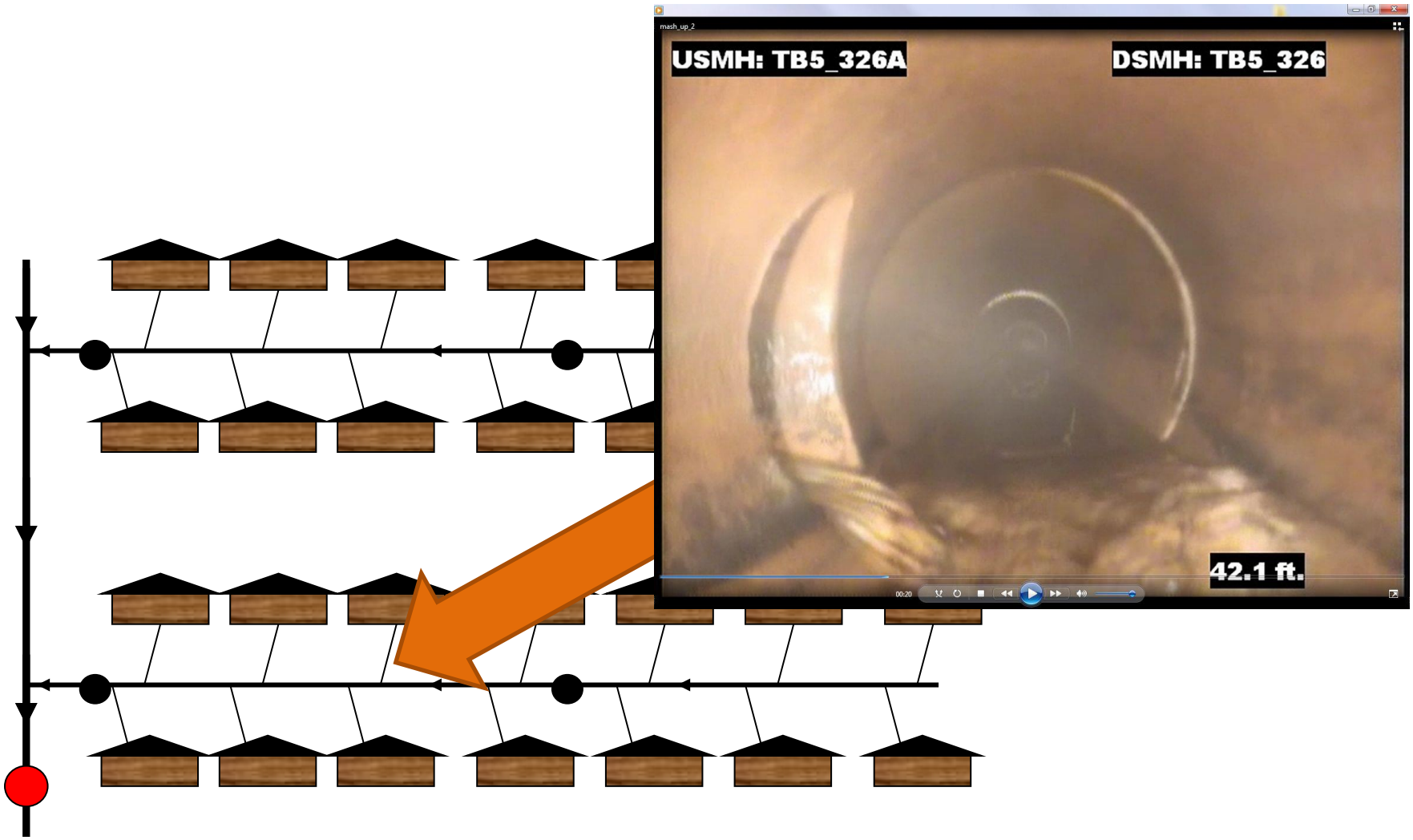
Micro Monitoring Investigation

- Reduce the System into smaller sewer sheds where traditional flow monitoring has not been successful
- Applicable in small diameter pipes (6" and 8")
- Significant conclusions may be drawn after a single storm event
- Allows a utility to focus CCTV, smoke and dye testing to small areas to reduce cost of investigation





Which House has the I/I?



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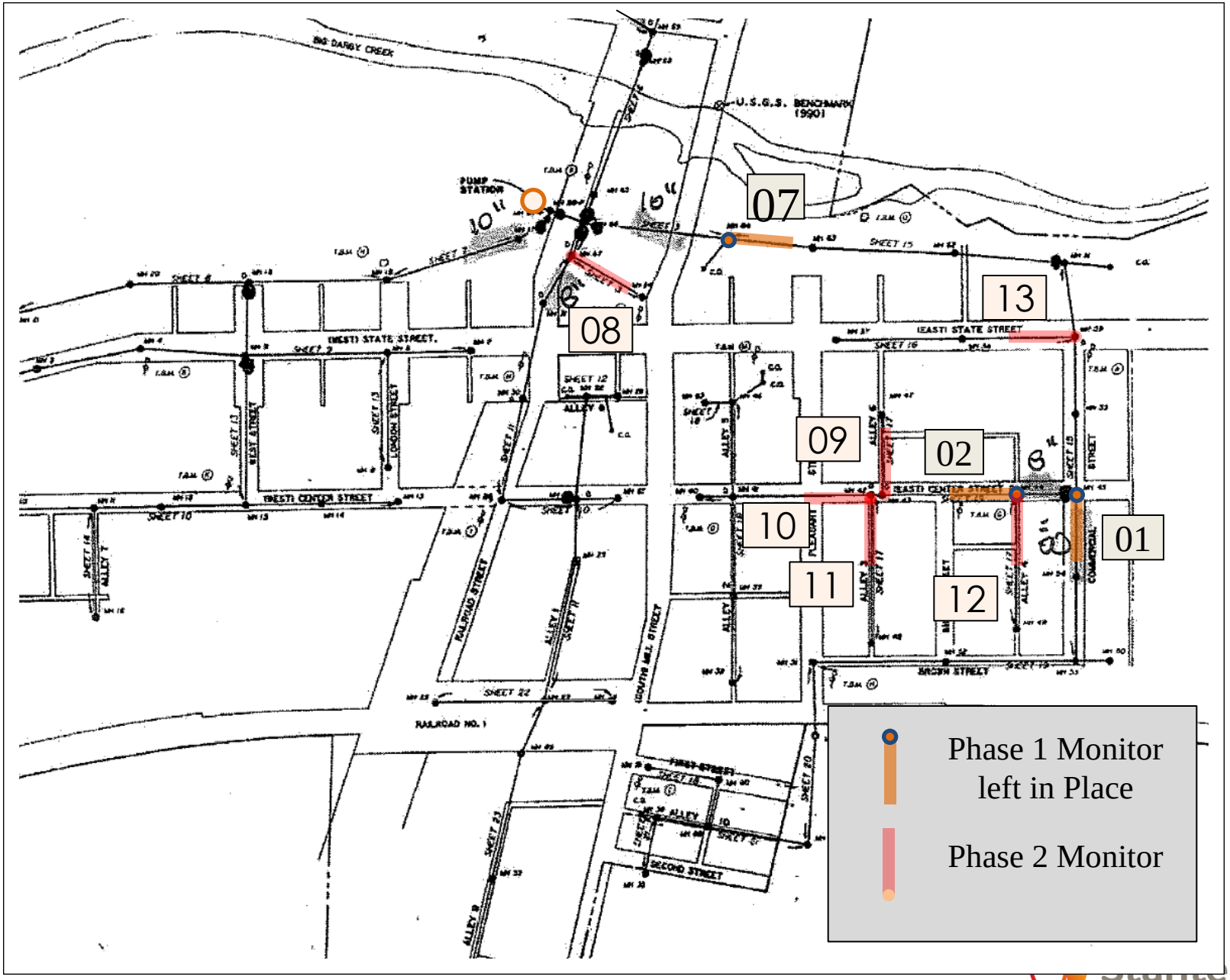
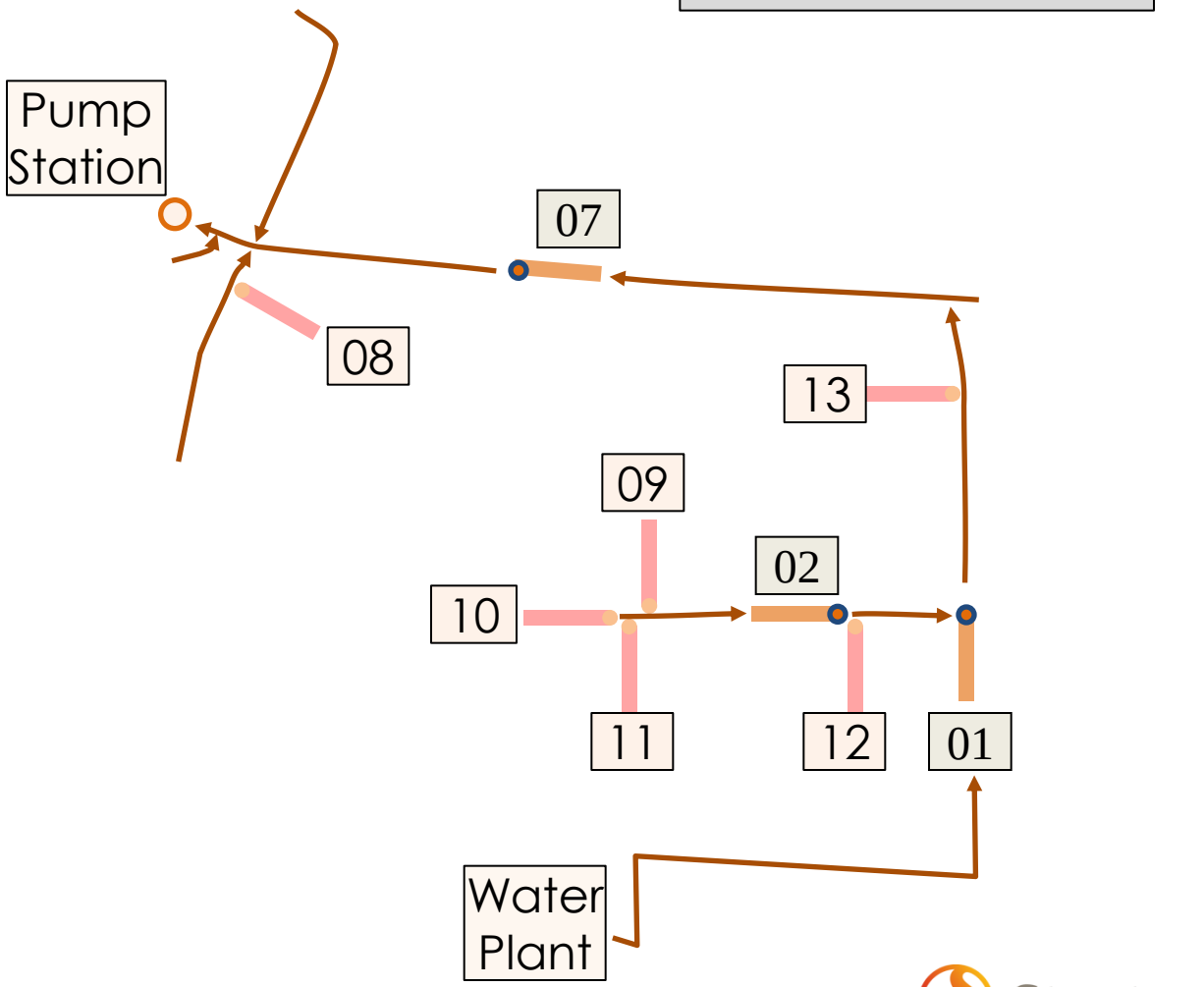
Milford Center - Meter Locations



Milford Center Schematic



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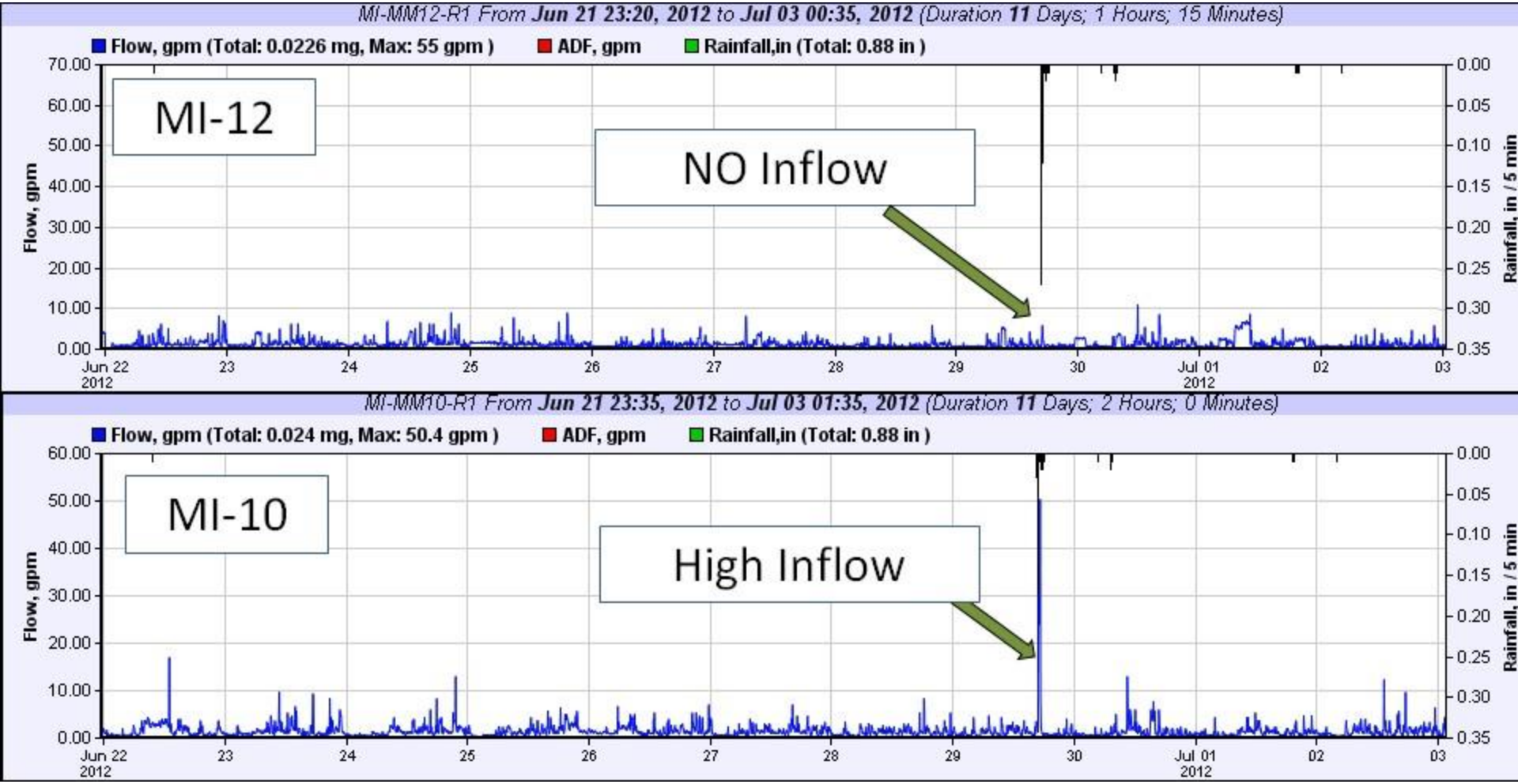
Milford Center - I/I Response



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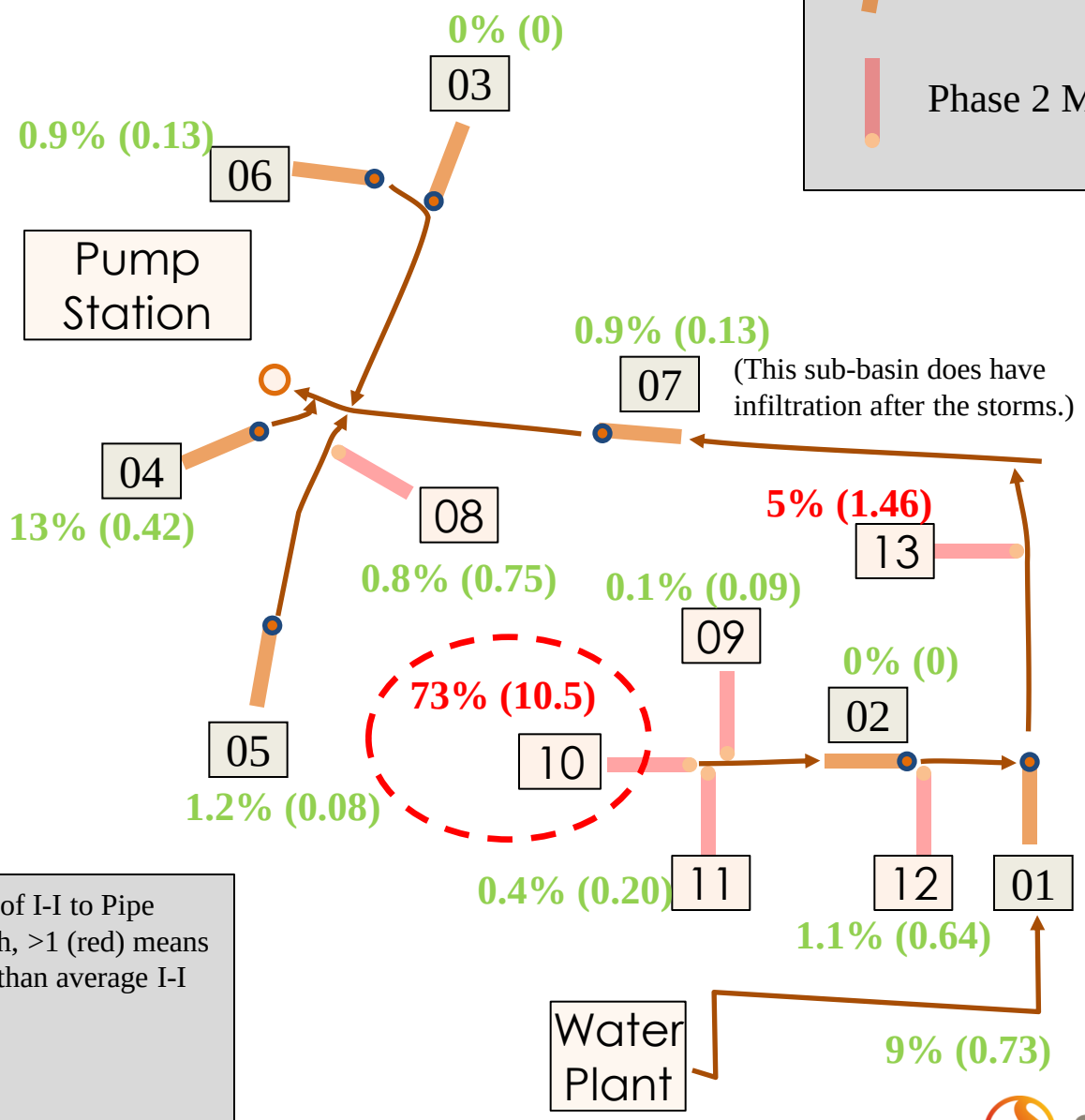
Milford Center Results



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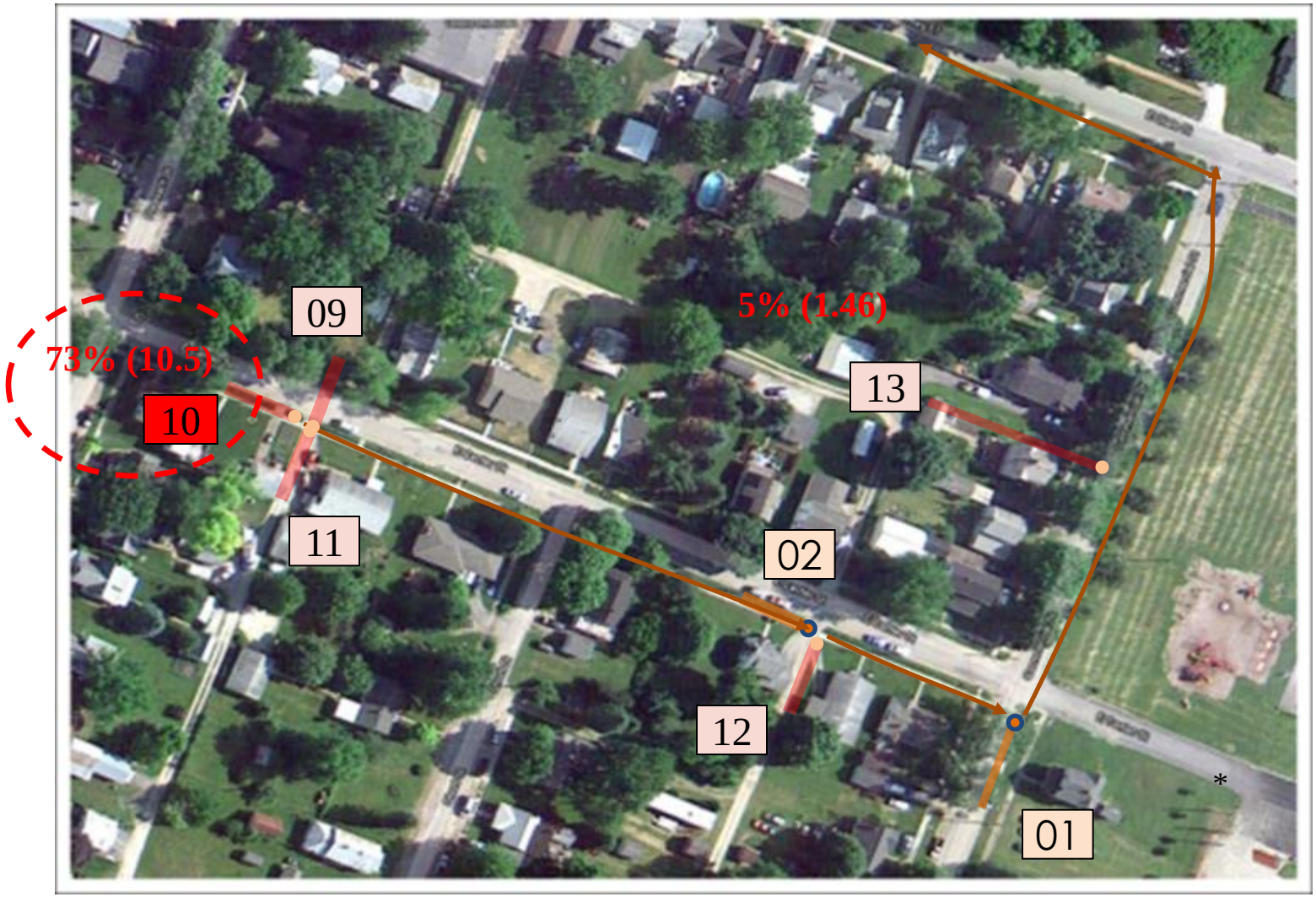
Milford Center – Pinpointing I/I Sources



Reduced investigation of 30,000 lf of sewer to 1,900 lf… saving the client time and financial resources

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Early Ditch Green Solutions

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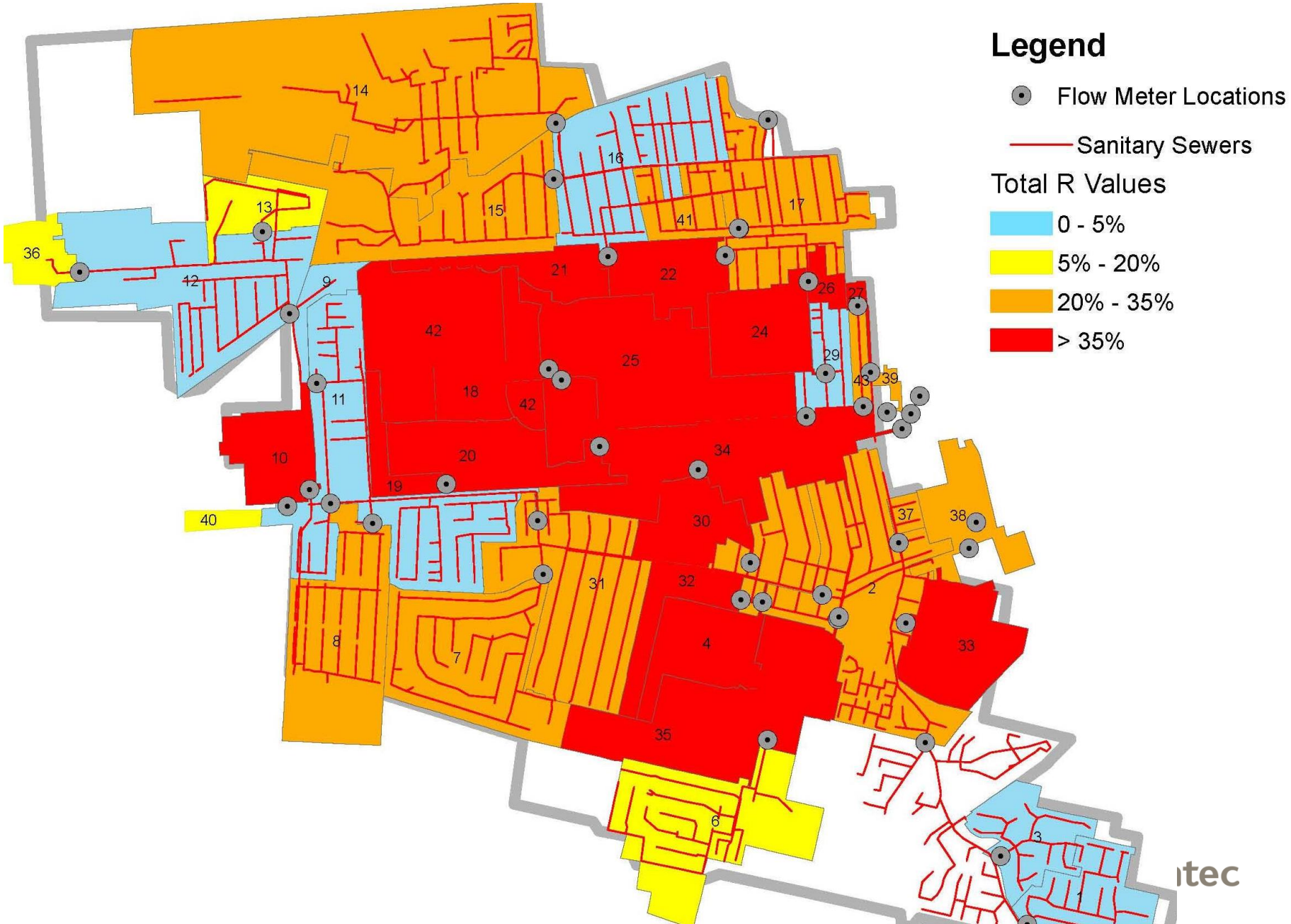
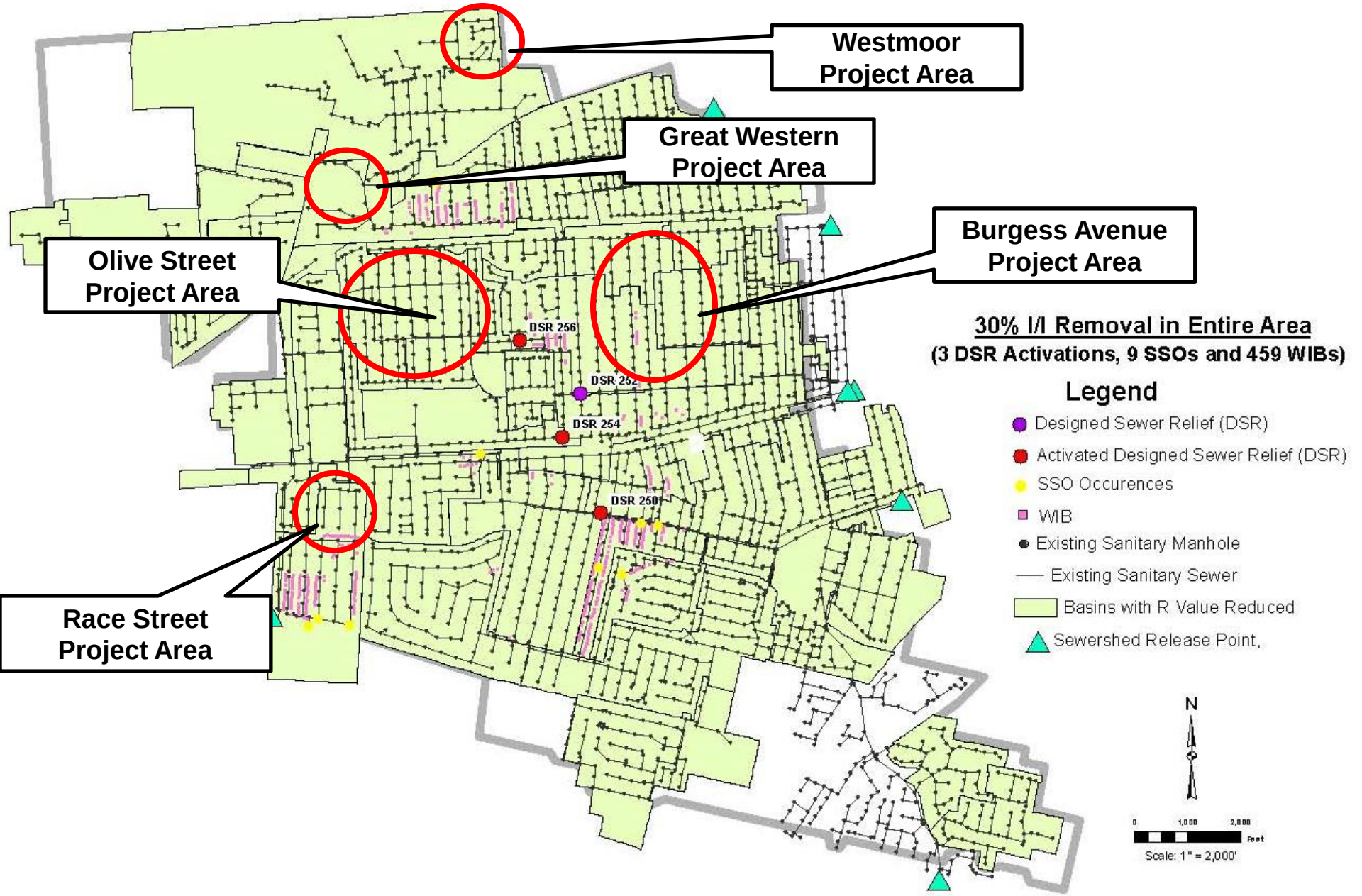
Existing Conditions Early Ditch I/I - R Factor: Where is I/I the Worst?

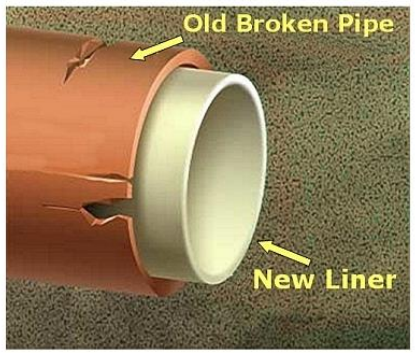


I/I Removal Approach – Target Locations 20%



Early Ditch Options Evaluated

- ☑ Increased Conveyance
- ☑ Storage
- ☑ Inflow and Infiltration Remediation
- ☑ Green Infrastructure
- ☒ Satellite Treatment



I/I Reduction – Literature Review

Reviewed 1,500+ published papers

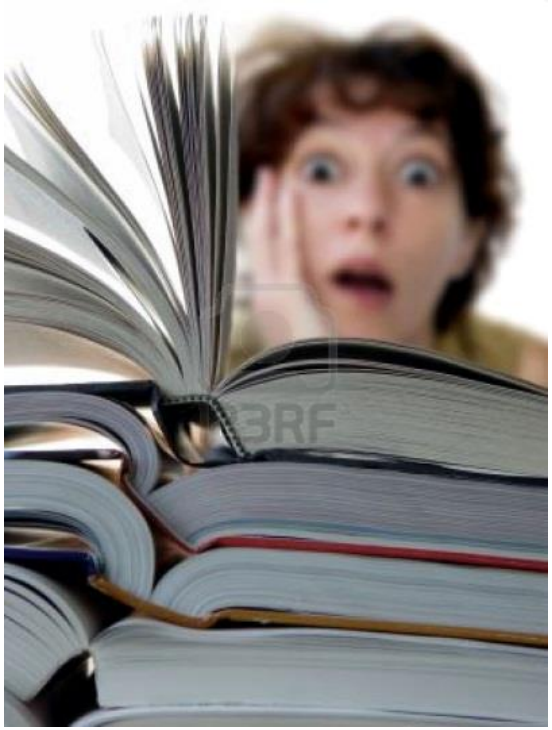
Found 23 with quantitative I/I removal results

Public

- **36% is attainable removal rate in ROW**

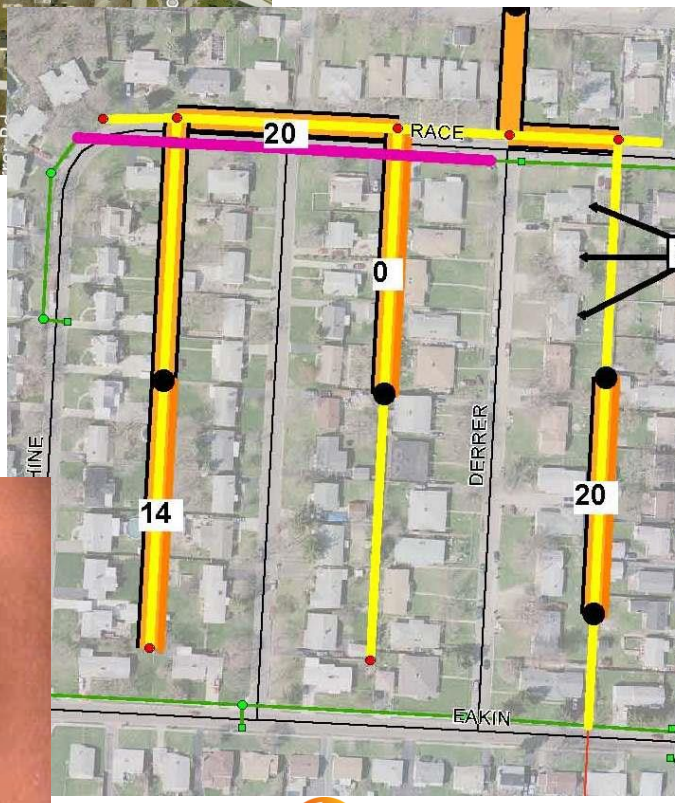
Private

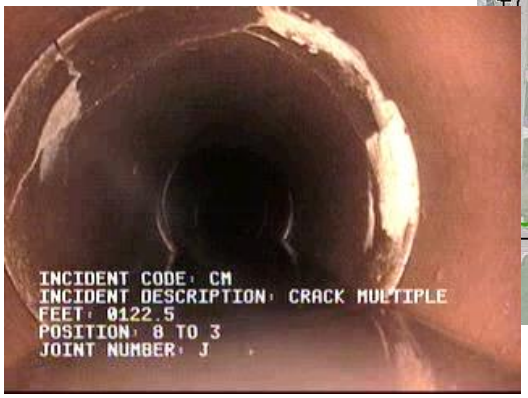
- **33% is attainable removal on private property**



Race Street Area

- Residential Neighborhood
- Close Proximity/ Co-Located Utilities
- Class 4 Defects
- Positive I/I Testing = 54 GPM





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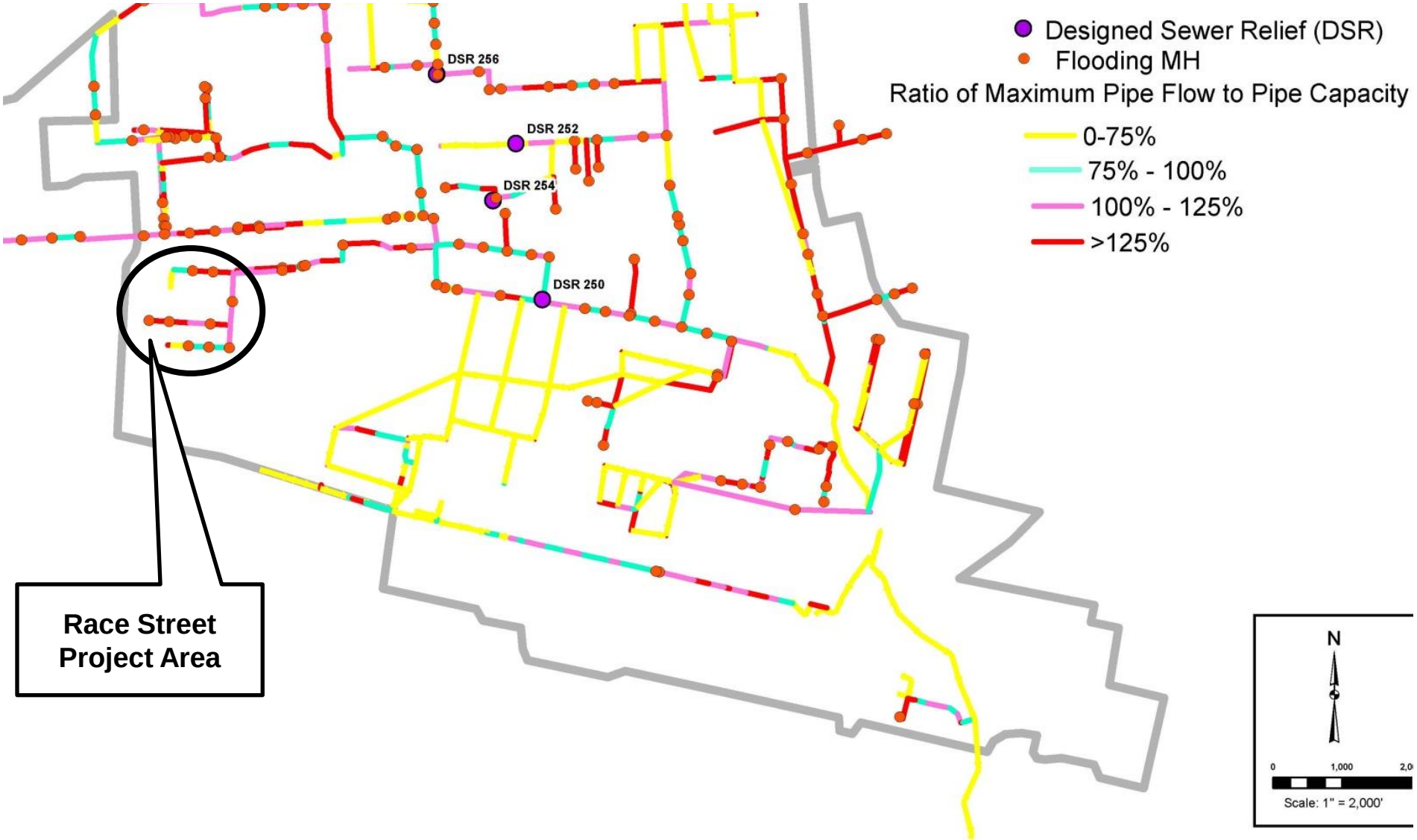
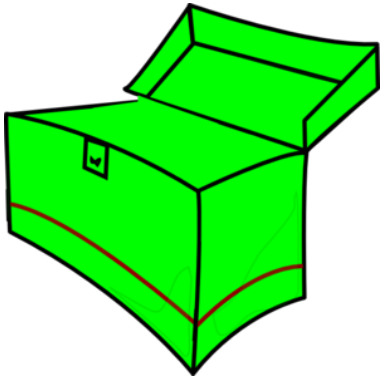
Race Street - Existing Storm System Capacity



Race Street Green Technologies?



Race Street Green Technologies, Cont.

Existing Abandoned Houses!!

- **Provides storage to reduce peak storm flows**
- **Relieves surcharged storm sewers**
- **Could be converted into…**

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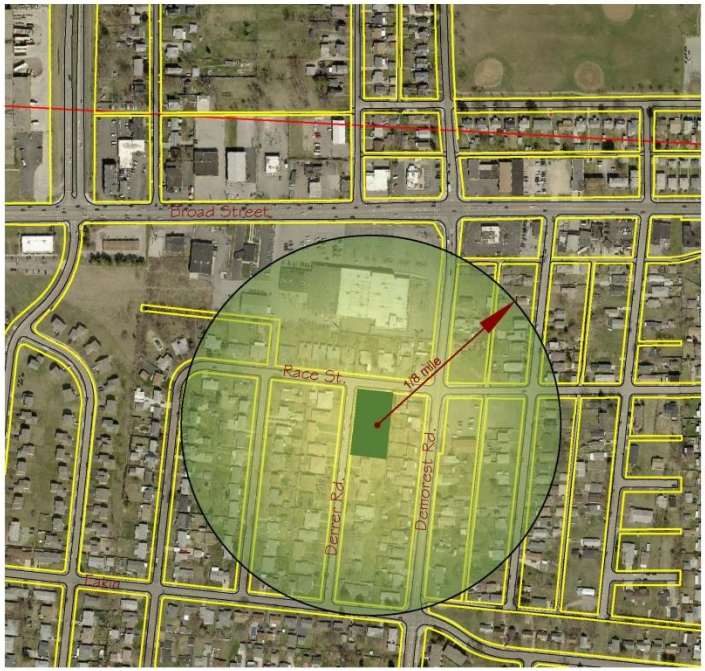
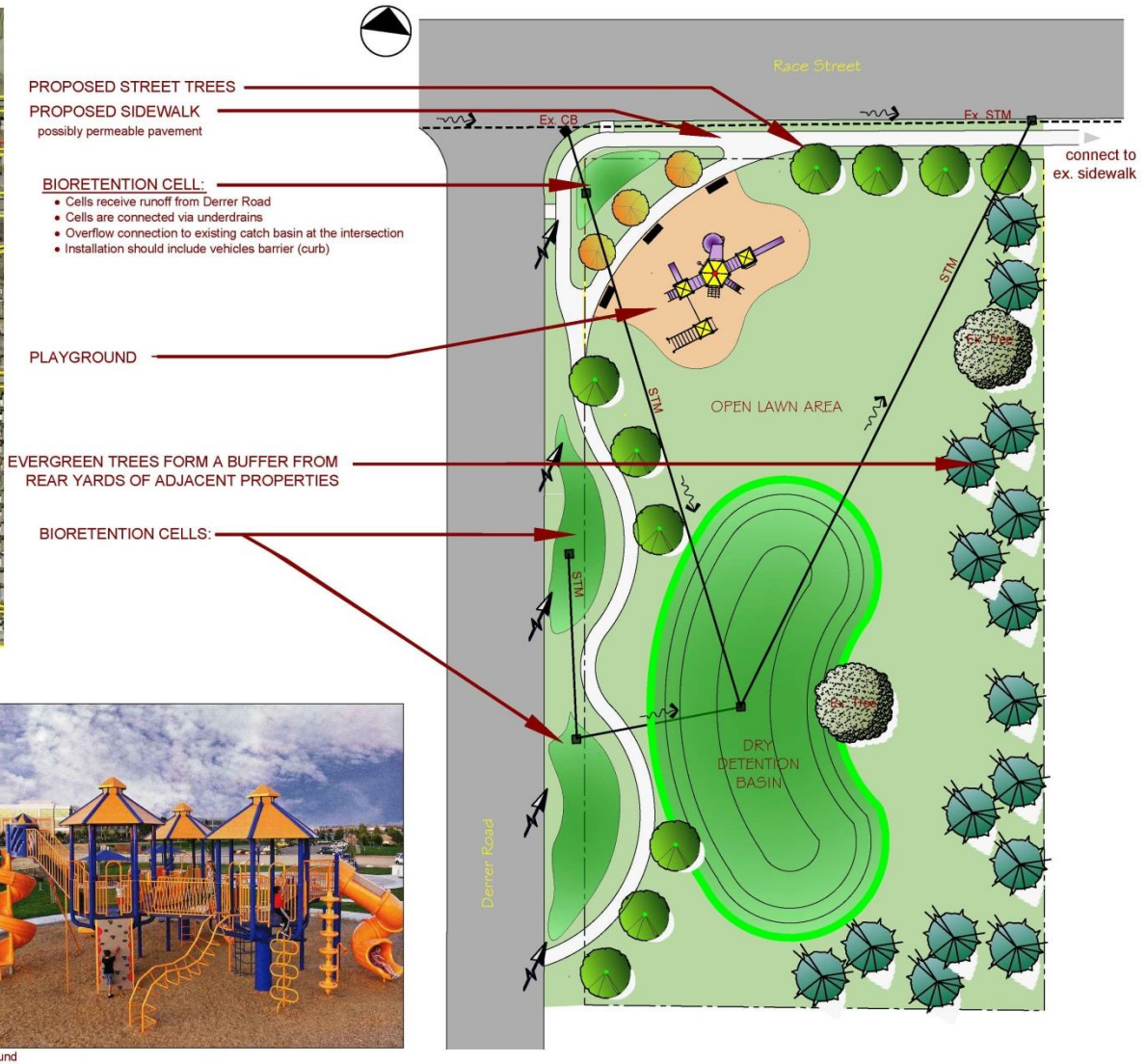
Race Street Project – Detention Basin & Park





Mini-Park characteristics per the National Recreation and Parks Association (NRPA):

- Serve a centralized or limited population or specific group such as young children or senior citizens
- Service Area is 1/8 to 1/4 mile of residential area - or a 5-minute walk (*City of Columbus' Recreation and Parks Master Plan* states: " A neighborhood park, community park or recreation facility should be located within one-half mile of all residents.")
- Desirable Size is 2,500 square feet to 2 acres
- Facilities and Activities include:
  - Playground,
  - Conversation and sitting areas arranged to permit easy surveillance by parents
  - Landscaped areas that provide buffering and shade
  - Lighting for security at night (direct cut-off)
  - Parking typically not required
- Desirable Site Characteristics:
  - Easily accessible to the neighborhood population
  - Located in close proximity to residential development
  - Accessible by walking or biking
  - Well buffered by open space and/or landscape plantings and separated from roadways by physical barriers, such as fences


Bikerack


Bench

Playground

Great Western Project

Collect runoff from impervious surfaces such as parking areas and roofs in bioretention cells and grassed swales. The quantity of water treated by the BMPs will depend on the space available.

Grassed Swale:

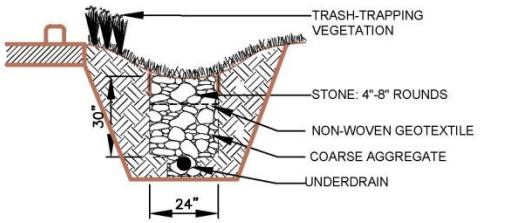
In the context of BMPS to improve water quality, the term swale (a.k.a. grassed channel, dry swale, wet swale, biofilter, or bioswale) refers to a vegetated, open-channel management practices designed specifically to treat and attenuate stormwater runoff for a specified water quality volume. As stormwater runoff flows along these channels, it is treated through vegetation slowing the water to allow sedimentation, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Variations of the grassed swale include the grassed channel, dry swale, and wet swale. The specific design features and methods of treatment differ in each of these designs, but all are improvements on the traditional drainage ditch. These designs incorporate modified geometry and other features for use of the swale as a treatment and conveyance practice.

US EPA Website

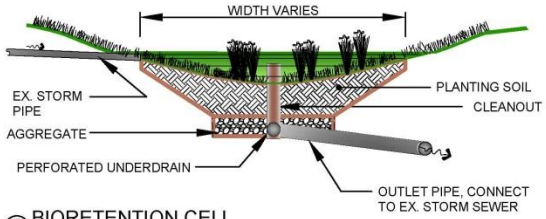
Bioretention Cell

Bioretention areas, or rain gardens, are landscaping features adapted to provide on-site treatment of stormwater runoff. They are commonly located in parking lot islands or within small pockets of residential land uses. Surface runoff is directed into shallow, landscaped depressions. These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems. During storms, runoff ponds above the mulch and soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the mulch and prepared soil mix. The filtered runoff can be collected in a perforated underdrain and returned to the storm drain system

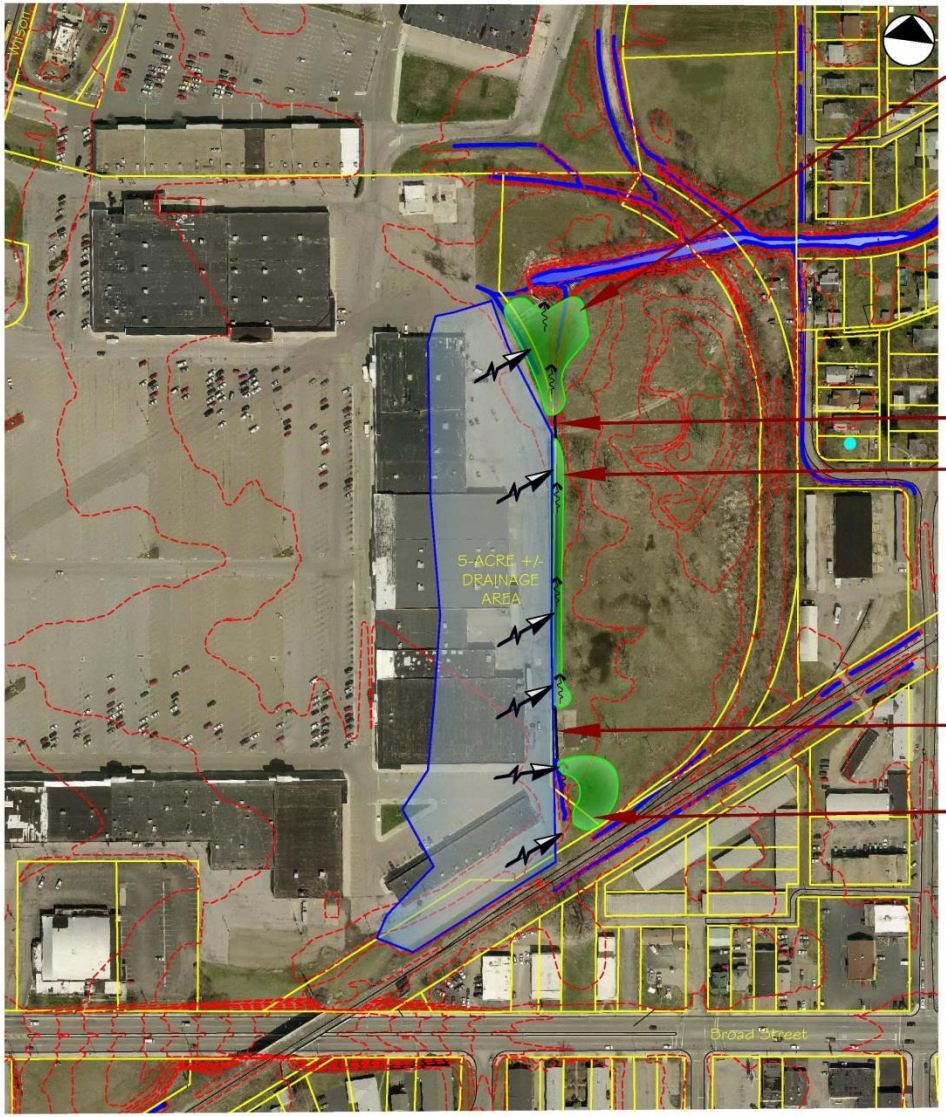
US EPA Website



A GRASSED SWALE WITH UNDERDRAIN
NOT TO SCALE



B BIORETENTION CELL
NOT TO SCALE



BIORETENTION CELL

Google Birdseye view showing proposed location of north bioretention cell

EX. STORM PIPE

GRASSED SWALE WITH UNDERDRAIN

Google Birdseye view showing proposed location of grassed swale

EX. STORM PIPE

BIORETENTION CELL

Google Birdseye view showing proposed locaion of south bioretention cell

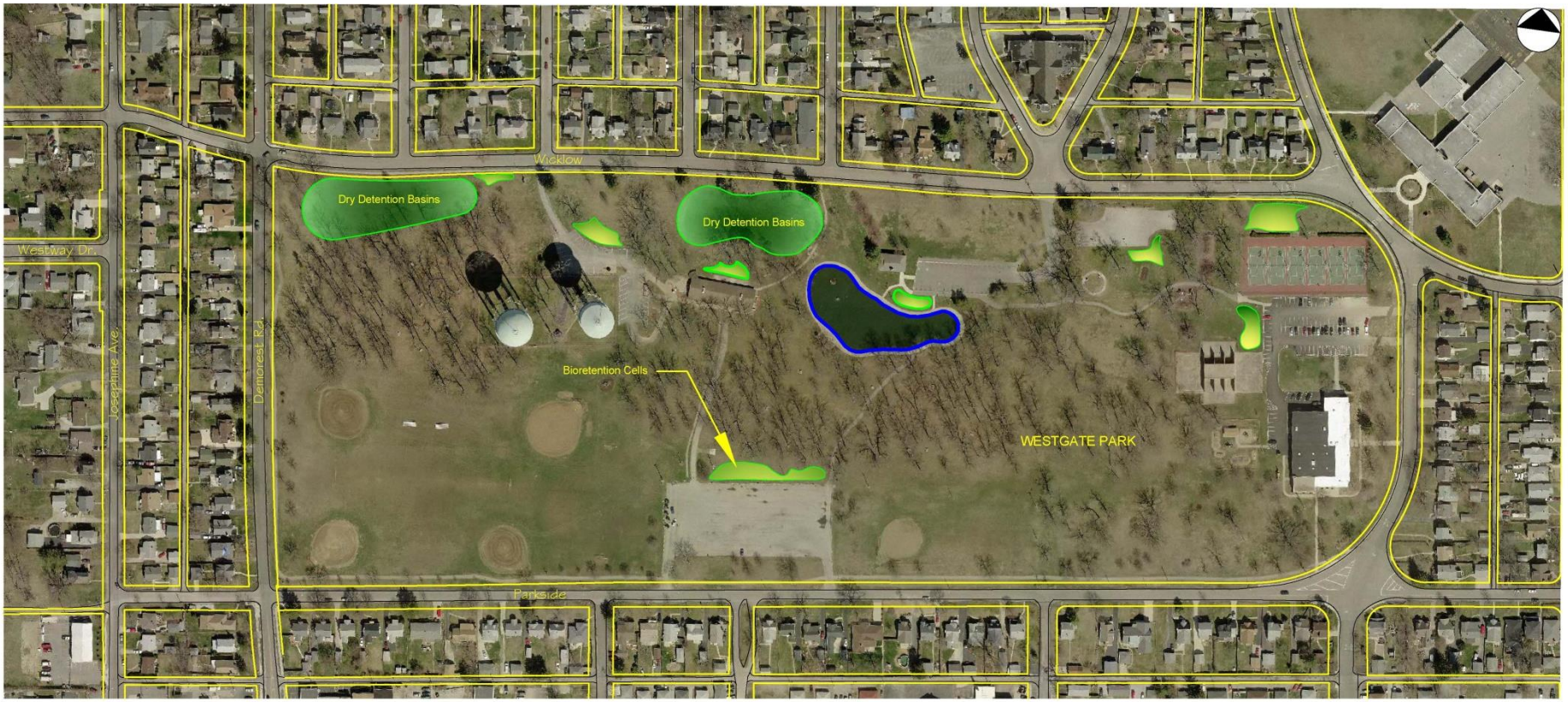
GREAT WESTERN DITCH IMPROVEMENT PROJECT

March 30, 2012

0' 200'

Stantec U:\7894\Early Ditch\1200 Reports – Deliverables\early ditch BMP landscape\bmp exhibit.dwg great western Apr 03, 2012 – 10:42:24am jlooby

Westgate Park Storm Project – Detention Basin



Google Birdseye view of Westgate Park showing potential locations for BMPs to treat parking and rooftop runoff.

Google Birdseye view of Westgate Park showing potential bioretention cell locations: low areas along the north side of the park.

WESTGATE PARK

Investigate opportunities to install dry detention basins in the low areas along the north edge of the park to manage stormwater runoff from the neighborhood to the west. The basins should be integral to the overall park and should not diminish from current park facilities and amenities.

BMPs such as bioretention cells and bioswales that could be installed within the park to treat runoff from parking areas, rooftops and other impervious surfaces should also be investigated.

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W E S T G A T E P A R K P R O J E C T

March 30, 2012

0' 200'

U:\7894\Early Ditch\1200 Reports – Deliverables\early ditch BMP landscape\bmp exhibit.dwg westgate park Apr 03, 2012 – 10:40:48am jlooby

Take Away Message

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Take Away Message

- Sanitary and storm system deficiencies are related. If an area is poorly drained, it most certainly experiences I/I
- Typically 50% of all system I/I is on private property
- Flow metering technology has evolved to the point where it can be a significant tool to locate I/I
- Green technology can be used in combination with gray to help address storm water drainage

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Questions?

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